B12

LAMINATED SEMICONDUCTOR SUBSTRATE

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Abstract

PURPOSE:To obtain a semiconductor substrate which is provided with a rejection formation layer with less defect density by forming a buffer layer structure which is superb in dislocation propagation rejection function.
CONSTITUTION:When forming a laminated type semiconductor substrate in a structure where a compound semiconductor single crystal such as GaAs is subjected to epitaxial growth on an Si substrate, stress caused by lattice mismatching was eliminated by generating misfit dislocation on a single crystal Si substrate 1, namely a fully thick InGaAs layer 2 which is sufficient for generating misfit dislocation is provided, a GaAs layer 3 which is doped with Zn is provided on it in a thickness so that no stress generated by misfit dislocation is eliminated, an InGaAs layer 4 is provided on it in a thickness so that no stress caused by misfit dislocation is eliminated, and then a target layer GaAs layer 5 is provided on it, thus enabling motion speed of a dislocation 7 being extended to the GaAs layer 3 to be large, frequently forming a loop in combination with other dislocations of the same type, and limiting dislocation density within the GaAs layer 5 which is the element formation layer. Zn which is doped to the GaAs layer 3 promotes move of dislocation.

CLAIMS

(57) [Claim(s)]

[Claim 1] The converter circuit characterized by providing the following The 1st low noise amplification means which consists of a semiconductor amplifier of the 2 steps of serial composition which amplifies a horizontally-polarized-wave signal The 2nd low noise amplification means which consists of a

semiconductor amplifier of the 2 steps of serial composition which amplifies a vertically-polarized-wave signal Switching means which supply the bias voltage from a power circuit to either the above 1st or the 2nd low noise amplification means according to the receive mode of the aforementioned horizontally-polarized-wave signal or the aforementioned vertically-polarized-wave signal The active mixer which changes into an intermediate frequency signal the band-pass filter from which a predetermined disturbance signal is removed, and the signal which passed the aforementioned band-pass filter including the semiconductor amplifier from the signal amplified with the above 1st or the 2nd low noise amplification means just behind the intersection of the output from the above 1st and the 2nd low noise amplification means
[Claim 2] It is the converter circuit according to claim 1 where the aforementioned semiconductor amplifier is an HEMT element, and the aforementioned low noise amplification means is characterized by the bird clapper from the HEMT element of 2 steps of serial composition.

[Translation done.]

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates the signal from the broadcasting satellite which received by the parabolic antenna to amplification and the converter circuit which carries out frequency conversion and which is outputted to a tuner circuit.
[0002]
[Description of the Prior Art] Drawing 5 is the block diagram showing the 1st example of the conventional converter circuit. This circuit shows amplification and the general composition of the low noise block down converter (henceforth LNB) for carrying out frequency conversion for the signal from broadcasting satellites, such as a European ASUTORA satellite.
[0003] Input frequency discriminates the horizontally-polarized-wave signal and vertically-polarized-wave signal which are 10.95GHz - 11.7GHz, carries out low noise amplification, changes this circuit into the 1st intermediate frequency around 1GHz (950MHz - 1700MHz), and outputs it to a latter tuner circuit (un-illustrating).
[0004] Moreover, the horizontally-polarized-wave signal HP is inputted into an input terminal 21, and, as for this circuit, the vertically-polarized-wave signal VP is inputted into an input terminal 22. the horizontally-polarized-wave signal HP is amplified by LNA (low noise amplifying circuit) of the three-step composition which consists of a HEMT (HEMT) element 23 and HEMT elements 24 and 25 of two-step composition, and the vertically-polarized-wave signal VP consists of HEMT element 26 and HEMT elements 24 and 25 of two-step composition -- similarly it is amplified by LNA of three-step composition
[0005] After having sent each horizontally-polarized-wave signal HP amplified by LNA, or the vertically-polarized-wave signal VP to the diode mixer 28 through the low pass filter 27, being mixed with the local oscillation signal from the local oscillation circuit 29, changing it into an intermediate frequency signal and being amplified by the signal of suitable level by the intermediate frequency amplifying circuit 30, it is outputted from an output terminal 31.
[0006] Selection of whether this converter circuit receives the horizontally-polarized-wave signal HP or to receive the vertically-polarized-wave signal VP is performed by switching alternatively the bias voltage supplied to HEMT elements 23 and 26. That is, if the bias voltage supplied from a power circuit 32 is switched by the switching circuit 33 and supplied to HEMT element 23, it will become receivable [the horizontally-polarized-wave signal HP], and if HEMT element 26 is supplied, it will become receivable [the vertically-polarized-wave signal VP]. A switch of a switching circuit 33 judges size or smallness by the comparator circuit 34 to a reference value with the supply voltage value of LNB, and is performed based on the judgment result.
[0007] Drawing 6 is the block diagram showing the 2nd example of the conventional converter circuit. In the circuit shown in drawing 5 mentioned above, if this circuit removes the point which constituted each of HEMT element 25, a diode mixer 28, the local oscillation circuit 29, and the intermediate frequency amplifying circuit 30 inside MMIC(microwave monolithic integrated circuit) 40, it has the same composition as the composition shown in drawing 5 mentioned above. And the fundamental principle of operation is the same as that of the circuit shown in drawing 5 .
[0008] Drawing 7 is the block diagram showing the 3rd example of the conventional converter circuit. In the circuit shown in drawing 5 mentioned above, if this circuit removes the point of having replaced

HEMT element 25 and the diode mixer 28 by the HEMT mixer 41 containing an HEMT element, it has the same composition as the composition shown in drawing 5 mentioned above. It is the same as that of the circuit which shows the fundamental principle of operation to drawing 5 also in this case.
[0009] Drawing 8 is the block diagram showing the 4th example of the conventional converter circuit. If the point constituted so that this circuit considers the number of stages of the HEMT element to which bias voltage is supplied as two-step composition in the circuit shown in drawing 5 mentioned above, respectively, HEMT element 42 might be connected to the latter part of HEMT element 23, and HEMT element 43 might be connected to the latter part of HEMT element 26, respectively and only HEMT element 24 might be used as a common element from the point of gain distribution is removed, it has the same composition as the composition shown in drawing 5 mentioned above. It is the same as that of the circuit which shows the fundamental principle of operation to drawing 5 also in this case.
[0010]
[Problem(s) to be Solved by the Invention] since [which was mentioned above] each **, the correspondence to wide-band-izing of the received frequency of the broadcasting satellite launched from now on is difficult for the circuit shown in drawing 5 - drawing 7 in an example, and the circuit shown in drawing 5 and drawing 8 has many part mark of a microwave element with expensive HEMT element, diode-mixer element, etc., and they have been disadvantageous in cost Moreover, since the conventional example shown in drawing 6 is larger than the case where the consumed electric current of MMIC uses an HEMT element independently, it is in the inclination which is inferior in respect of reliability.
[0011] Then, this invention aims at solving each following technical problem.
** Realize the low noise amplification property and frequency-conversion property in the wide band exceeding 1GHz.
** 30dB or more should be obtained over the wide band to which the isolation property at the time of reception of a horizontally-polarized-wave signal or reception of a vertically-polarized-wave signal (degree of separation of a horizontally-polarized-wave signal and a vertically-polarized-wave signal) exceeds 1GHz.
** In order to attain low-cost-ization, lessen part mark as much as possible.
** Make the comprehensive gain difference and frequency characteristic difference of each polarization signal at the time of horizontally-polarized-wave signal reception and vertically-polarized-wave signal reception as small as possible.
[0012]
[Means for Solving the Problem] 1st low noise amplification means by which the converter circuit by this invention consists of a semiconductor amplifier of the 2 steps of serial composition which amplifies a horizontally-polarized-wave signal, The 2nd low noise amplification means which consists of a semiconductor amplifier of the 2 steps of serial composition which amplifies a vertically-polarized-wave signal, The switching means which supply the bias voltage from a power circuit to either of the 1st or 2nd low noise amplification means according to the receive mode of the horizontally-polarized-wave signal or a vertically-polarized-wave signal, The band-pass filter which removes a predetermined disturbance signal from the signal amplified with the 1st or 2nd low noise amplification means just behind the intersection of the output from the 1st and 2nd low noise amplification means, It has the active mixer which changes into an intermediate frequency signal the signal which passed the aforementioned band-pass filter including the semiconductor amplifier.
[0013] In this case, using an HEMT element as a semiconductor amplifier, you may constitute so that the HEMT element of 2 steps of serial composition may be used as a low noise amplification means.
[0014]
[Function] In the composition of this invention, if bias voltage is supplied to the 1st low noise amplification means by switching means, a horizontally-polarized-wave signal will be amplified by the 1st low noise amplification means, and it will decrease by 2nd low noise amplification means by which the vertically-polarized-wave signal is not operating. If bias voltage is supplied to the 2nd low noise amplification means by switching means contrary to this, a vertically-polarized-wave signal will be amplified by the 2nd low noise amplification means, and it will decrease by 1st low noise amplification means by which the horizontally-polarized-wave signal is not operating.
[0015] Consequently, since the low noise amplification means consists of two or more steps of semiconductor amplifiers, for example, the HEMT element of two-step composition, compared with the case of one-step composition, a wide band low noise amplification property can be acquired, and the isolation property of both the polarization signal also becomes a twice [about] as many size as this.

Moreover, an element number can be decreased by constituting the frequency-conversion section from an active mixer containing a semiconductor amplifier, without changing gain distribution.
[0016]
[Example] Drawing 1 is the block diagram showing one example of the converter circuit by this invention. this example is equipped with the input terminal 1 into which the horizontally-polarized-wave signal HP is inputted, and the input terminal 2 into which the vertically-polarized-wave signal VP is inputted. An input terminal 1 is connected to the 1st low noise amplifying circuit (LNA) A1 which consists of HEMT elements 3 and 4 of two-step composition, and an input terminal 2 is connected to the 2nd low noise amplifying circuit (LNA) A2 which similarly consists of HEMT elements 5 and 6 of two-step composition.
[0017] Both the outputs of HEMT elements 4 and 6 of each latter part of LNA are connected to a band-pass filter 7, and the output is further connected to the HEMT mixer 8. Band-pass filters 7 are two or more tie way band pass filter composition depended on a microstrip line, and aim at image removal.
[0018] The HEMT mixer 8 consists of a series circuit of HEMT element 8a and mixer 8b, and the local oscillation signal from the local oscillation circuit 9 is supplied to mixer 8b. It connects with an output terminal 11 through the intermediate frequency amplifying circuit 10, and the output of the HEMT mixer 8 is connected to a tuner circuit through a non-illustrated interconnection cable. In addition, the intermediate frequency amplifying circuit 10 has three-step composition of general-purpose IC, and the consumed electric current in a total is about 110mA and the low consumed electric current.
[0019] By the way, from a latter tuner circuit, supply of power in a converter circuit shares an interconnection cable, and is supplied. The supplied power is supplied to a power circuit 13 through the choke circuit 12. A power circuit 13 supplies direct current voltage to each circuit of a converter circuit. However, the switching circuit 14 is minded [HEMT elements 3 and 4 which are LNA(s) for horizontally-polarized-wave signals, and / which are LNA(s) for vertically-polarized-wave signals / 5 and 6], and they are supplied alternatively only at one [a gap or] LNA.
[0020] A switching circuit 14 is switched alternatively and controlled by the output of a comparator circuit 15. To the predetermined reference value which supply voltage set up beforehand, a comparator circuit 15 judges whether it is large or small, and switches a switching circuit 14 according to the result.
[0021] Each element which constitutes a converter circuit is mounted on the one-sheet substrate made from the Teflon material excellent in the RF property, and wiring consists of microstrip lines. As for this circuit, the HEMT element uses one element [a total of six] for four elements and the HEMT mixer 8 in one element and the local oscillation circuit 9 at LNA.
[0022] Next, operation of the converter circuit by this example is explained. this example serves as the vertically-polarized-wave signal receive mode, when supply voltage is 11.5-14.0V, and when supply voltage is 16.0-19.0V, the reference value of a comparator circuit 15 is set as 15.0V so that it may become the horizontally-polarized-wave signal receive mode.
[0023] Now, supposing supply voltage is 13.0V, it judges that a comparator circuit 15 is below a reference value, and a switching circuit 14 will be controlled and bias voltage will be supplied to HEMT elements 5 and 6 which are the 2nd LNA. Thereby, a converter circuit serves as the vertically-polarized-wave signal receive mode. Therefore, low noise amplification is carried out by HEMT elements 5 and 6, an image-frequency signal (7.7 GHz to 8.8GHz) is removed with a band-pass filter 7, and the vertically-polarized-wave signal VP inputted into the input terminal 2 is supplied to the HEMT mixer 8.
[0024] It is the so-called active mixer, and before carrying out frequency conversion of the HEMT mixer 8 by mixer 8b, in order that it may amplify a signal by HEMT element 8a, it is a mixer which has a conversion gain. It is mixed with the local oscillation signal (9.75GHz) from the local oscillation circuit 9, and the vertically-polarized-wave signal VP supplied to the HEMT mixer 8 is changed into an intermediate frequency signal (950 MHz - 2050MHz), is amplified by suitable level by the intermediate frequency amplifying circuit 10, and is outputted from an output terminal 11.
[0025] While the converter circuit is the vertically-polarized-wave signal receive mode, since bias voltage is not supplied to HEMT elements 3 and 4, it is in the non-operative state. For this reason, the horizontally-polarized-wave signal HP is decreased by HEMT elements 3 and 4, and only few signals get across to a latter circuit. Although the relative-level difference of the vertically-polarized-wave signal and horizontally-polarized-wave signal which are outputted from an output terminal 11 is called an isolation property or cross polarization signature, the degree of separation of both the polarization signal will be so high that this difference is large, and it will be desirable.
[0026] Next, if supply voltage is set to 17.0V, a comparator circuit 15 will judge beyond as a reference

value, will switch a switching circuit 14, and will supply bias voltage to HEMT elements 3 and 4. Thereby, a converter circuit serves as the horizontally-polarized-wave signal receive mode, after low noise amplification is carried out by HEMT elements 3 and 4, and a horizontally-polarized-wave signal is supplied to a band-pass filter 7 and changed into an intermediate frequency signal (950 MHz - 2050MHz) with the HEMT mixer 8, is amplified by suitable level by the intermediate frequency amplifying circuit 10, and is outputted from an output terminal 11.
[0027] Drawing 2 is the graph which compared the relative output level of the vertically-polarized-wave signal VP at the time of vertically-polarized-wave signal reception, and the horizontally-polarized-wave signal HP. This graph shows the output frequency (0.2 GHz/div) to the vertical axis on the horizontal axis of input frequency (0.2 GHz/div) and a top at the horizontal axis of a relative output level (10 dB/div) and the bottom, respectively. the 1.1GHz wide band over of [this circuit has obtained 31dB as the minimum value of isolation so that clearly from this graph, and] 10.7GHz - 11.8GHz in input frequency -- it turns out that it has high degree of separation [0028] Drawing 3 is the graph which compared the relative output level of the horizontally-polarized-wave signal HP at the time of horizontally-polarized-wave signal reception, and the vertically-polarized-wave signal VP. The output frequency (0.2 GHz/div) is shown in the vertical axis on the horizontal axis of input frequency (0.2 GHz/div) and a top like [this graph] drawing 2 at the horizontal axis of a relative output level (10 dB/div) and the bottom, respectively. the wide band over whose input frequency 31dB has been obtained as the minimum value of isolation also in this case, and is 10.7GHz - 11.8GHz -- it has high degree of separation
[0029] Drawing 4 is the graph which shows comprehensive gain and a noise figure property, the comprehensive gain PG (2 dB/div) is shown in the vertical axis of a noise figure NF (0.1 dB/div) and the right, and input frequency (0.1 GHz/div) is shown in the horizontal axis at the left vertical axis, respectively. A solid line expresses the time of reception of the vertically-polarized-wave signal VP among drawing, and the dashed line expresses the time of reception of the horizontally-polarized-wave signal HP. It turns out in the time of reception of a vertically-polarized-wave signal, and reception of a horizontally-polarized-wave signal that the difference of the frequency characteristic of the comprehensive gain PG is a **1-**2dB small margin so that clearly from this graph.
[0030]
[Effect of the Invention] According to this invention, a low noise amplification property, a frequency-conversion property, an isolation property, the frequency characteristic of comprehensive gain, etc. can obtain a good converter circuit over the wide band to which input frequency exceeds 1GHz. Moreover, since the part mark of an expensive microwave element can be cut down without reducing a performance, it is improvable also in cost.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Drawing 5 is the block diagram showing the 1st example of the conventional converter circuit. This circuit shows amplification and the general composition of the low noise block down converter (henceforth LNB) for carrying out frequency conversion for the signal from broadcasting satellites, such as a European ASUTORA satellite.
[0003] Input frequency discriminates the horizontally-polarized-wave signal and vertically-polarized-wave signal which are 10.95GHz - 11.7GHz, carries out low noise amplification, changes this circuit into the 1st intermediate frequency around 1GHz (950MHz - 1700MHz), and outputs it to a latter tuner circuit (un-illustrating).
[0004] Moreover, the horizontally-polarized-wave signal HP is inputted into an input terminal 21, and, as for this circuit, the vertically-polarized-wave signal VP is inputted into an input terminal 22. the horizontally-polarized-wave signal HP is amplified by LNA (low noise amplifying circuit) of the three-step composition which consists of a HEMT (HEMT) element 23 and HEMT elements 24 and 25 of two-step composition, and the vertically-polarized-wave signal VP consists of HEMT element 26 and HEMT elements 24 and 25 of two-step composition -- similarly it is amplified by LNA of three-step composition
[0005] After having sent each horizontally-polarized-wave signal HP amplified by LNA, or the vertically-polarized-wave signal VP to the diode mixer 28 through the low pass filter 27, being mixed with the

local oscillation signal from the local oscillation circuit 29, changing it into an intermediate frequency signal and being amplified by the signal of suitable level by the intermediate frequency amplifying circuit 30, it is outputted from an output terminal 31.
[0006] Selection of whether this converter circuit receives the horizontally-polarized-wave signal HP or to receive the vertically-polarized-wave signal VP is performed by switching alternatively the bias voltage supplied to HEMT elements 23 and 26. That is, if the bias voltage supplied from a power circuit 32 is switched by the switching circuit 33 and supplied to HEMT element 23, it will become receivable [the horizontally-polarized-wave signal HP], and if HEMT element 26 is supplied, it will become receivable [the vertically-polarized-wave signal VP]. A switch of a switching circuit 33 judges size or smallness by the comparator circuit 34 to a reference value with the supply voltage value of LNB, and is performed based on the judgment result.
[0007] Drawing 6 is the block diagram showing the 2nd example of the conventional converter circuit. In the circuit shown in drawing 5 mentioned above, if this circuit removes the point which constituted each of HEMT element 25, a diode mixer 28, the local oscillation circuit 29, and the intermediate frequency amplifying circuit 30 inside MMIC(microwave monolithic integrated circuit) 40, it has the same composition as the composition shown in drawing 5 mentioned above. And the fundamental principle of operation is the same as that of the circuit shown in drawing 5 .
[0008] Drawing 7 is the block diagram showing the 3rd example of the conventional converter circuit. In the circuit shown in drawing 5 mentioned above, if this circuit removes the point of having replaced HEMT element 25 and the diode mixer 28 by the HEMT mixer 41 containing an HEMT element, it has the same composition as the composition shown in drawing 5 mentioned above. It is the same as that of the circuit which shows the fundamental principle of operation to drawing 5 also in this case.
[0009] Drawing 8 is the block diagram showing the 4th example of the conventional converter circuit. If the point constituted so that this circuit considers the number of stages of the HEMT element to which bias voltage is supplied as two-step composition in the circuit shown in drawing 5 mentioned above, respectively, HEMT element 42 might be connected to the latter part of HEMT element 23, and HEMT element 43 might be connected to the latter part of HEMT element 26, respectively and only HEMT element 24 might be used as a common element from the point of gain distribution is removed, it has the same composition as the composition shown in drawing 5 mentioned above. It is the same as that of the circuit which shows the fundamental principle of operation to drawing 5 also in this case.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] this invention relates the signal from the broadcasting satellite which received by the parabolic antenna to amplification and the converter circuit which carries out frequency conversion and which is outputted to a tuner circuit.

[Translation done.]

MEANS

[Means for Solving the Problem] It is characterized by equipping the converter circuit by this invention with the following. The 1st low noise amplification means which consists of a semiconductor amplifier of the 2 steps of serial composition which amplifies a horizontally-polarized-wave signal The 2nd low noise amplification means which consists of a semiconductor amplifier of the 2 steps of serial composition which amplifies a vertically-polarized-wave signal Switching means which supply the bias voltage from a power circuit to either of the 1st or 2nd low noise amplification means according to the receive mode of the horizontally-polarized-wave signal or a vertically-polarized-wave signal The active mixer which changes into an intermediate frequency signal the band-pass filter from which a predetermined disturbance signal is removed, and the signal which passed the aforementioned band-pass filter including the semiconductor amplifier from the signal amplified with the 1st or 2nd low noise

amplification means just behind the intersection of the output from the 1st and 2nd low noise amplification means
[0013] In this case, using an HEMT element as a semiconductor amplifier, you may constitute so that the HEMT element of 2 steps of serial composition may be used as a low noise amplification means.

[Translation done.]
OPERATION

[Function] In the composition of this invention, if bias voltage is supplied to the 1st low noise amplification means by switching means, a horizontally-polarized-wave signal will be amplified by the 1st low noise amplification means, and it will decrease by 2nd low noise amplification means by which the vertically-polarized-wave signal is not operating. If bias voltage is supplied to the 2nd low noise amplification means by switching means contrary to this, a vertically-polarized-wave signal will be amplified by the 2nd low noise amplification means, and it will decrease by 1st low noise amplification means by which the horizontally-polarized-wave signal is not operating.
[0015] Consequently, since the low noise amplification means consists of two or more steps of semiconductor amplifiers, for example, the HEMT element of two-step composition, compared with the case of one-step composition, a wide band low noise amplification property can be acquired, and the isolation property of both the polarization signal also becomes a twice [about] as many size as this. Moreover, an element number can be decreased by constituting the frequency-conversion section from an active mixer containing a semiconductor amplifier, without changing gain distribution.

[Translation done.]

OPERATION

[Function] In the composition of this invention, if bias voltage is supplied to the 1st low noise amplification means by switching means, a horizontally-polarized-wave signal will be amplified by the 1st low noise amplification means, and it will decrease by 2nd low noise amplification means by which the vertically-polarized-wave signal is not operating. If bias voltage is supplied to the 2nd low noise amplification means by switching means contrary to this, a vertically-polarized-wave signal will be amplified by the 2nd low noise amplification means, and it will decrease by 1st low noise amplification means by which the horizontally-polarized-wave signal is not operating.
[0015] Consequently, since the low noise amplification means consists of two or more steps of semiconductor amplifiers, for example, the HEMT element of two-step composition, compared with the case of one-step composition, a wide band low noise amplification property can be acquired, and the isolation property of both the polarization signal also becomes a twice [about] as many size as this. Moreover, an element number can be decreased by constituting the frequency-conversion section from an active mixer containing a semiconductor amplifier, without changing gain distribution.

[Translation done.]

EXAMPLE

[Example] Drawing 1 is the block diagram showing one example of the converter circuit by this invention. this example is equipped with the input terminal 1 into which the horizontally-polarized-wave signal HP is inputted, and the input terminal 2 into which the vertically-polarized-wave signal VP is inputted. An input terminal 1 is connected to the 1st low noise amplifying circuit (LNA) A1 which consists of HEMT elements 3 and 4 of two-step composition, and an input terminal 2 is connected to the 2nd low noise amplifying circuit (LNA) A2 which similarly consists of HEMT elements 5 and 6 of two-step composition.

[0017] Both the outputs of HEMT elements 4 and 6 of each latter part of LNA are connected to a band-pass filter 7, and the output is further connected to the HEMT mixer 8. Band-pass filters 7 are two or more tie way band pass filter composition depended on a microstrip line, and aim at image removal.
[0018] The HEMT mixer 8 consists of a series circuit of HEMT element 8a and mixer 8b, and the local oscillation signal from the local oscillation circuit 9 is supplied to mixer 8b. It connects with an output terminal 11 through the intermediate frequency amplifying circuit 10, and the output of the HEMT mixer 8 is connected to a tuner circuit through a non-illustrated interconnection cable. In addition, the intermediate frequency amplifying circuit 10 has three-step composition of general-purpose IC, and the consumed electric current in a total is about 110mA and the low consumed electric current.
[0019] By the way, from a latter tuner circuit, supply of power in a converter circuit shares an interconnection cable, and is supplied. The supplied power is supplied to a power circuit 13 through the choke circuit 12. A power circuit 13 supplies direct current voltage to each circuit of a converter circuit. However, the switching circuit 14 is minded [HEMT elements 3 and 4 which are LNA(s) for horizontally-polarized-wave signals, and / which are LNA(s) for vertically-polarized-wave signals / 5 and 6], and they are supplied alternatively only at one [a gap or] LNA.
[0020] A switching circuit 14 is switched alternatively and controlled by the output of a comparator circuit 15. To the predetermined reference value which supply voltage set up beforehand, a comparator circuit 15 judges whether it is large or small, and switches a switching circuit 14 according to the result.
[0021] Each element which constitutes a converter circuit is mounted on the one-sheet substrate made from the Teflon material excellent in the RF property, and wiring consists of microstrip lines. As for this circuit, the HEMT element uses one element [a total of six] for four elements and the HEMT mixer 8 in one element and the local oscillation circuit 9 at LNA.
[0022] Next, operation of the converter circuit by this example is explained. this example serves as the vertically-polarized-wave signal receive mode, when supply voltage is 11.5-14.0V, and when supply voltage is 16.0-19.0V, the reference value of a comparator circuit 15 is set as 15.0V so that it may become the horizontally-polarized-wave signal receive mode.
[0023] Now, supposing supply voltage is 13.0V, it judges that a comparator circuit 15 is below a reference value, and a switching circuit 14 will be controlled and bias voltage will be supplied to HEMT elements 5 and 6 which are the 2nd LNA. Thereby, a converter circuit serves as the vertically-polarized-wave signal receive mode. Therefore, low noise amplification is carried out by HEMT elements 5 and 6, an image-frequency signal (7.7 GHz to 8.8GHz) is removed with a band-pass filter 7, and the vertically-polarized-wave signal VP inputted into the input terminal 2 is supplied to the HEMT mixer 8.
[0024] It is the so-called active mixer, and before carrying out frequency conversion of the HEMT mixer 8 by mixer 8b, in order that it may amplify a signal by HEMT element 8a, it is a mixer which has a conversion gain. It is mixed with the local oscillation signal (9.75GHz) from the local oscillation circuit 9, and the vertically-polarized-wave signal VP supplied to the HEMT mixer 8 is changed into an intermediate frequency signal (950 MHz - 2050MHz), is amplified by suitable level by the intermediate frequency amplifying circuit 10, and is outputted from an output terminal 11.
[0025] While the converter circuit is the vertically-polarized-wave signal receive mode, since bias voltage is not supplied to HEMT elements 3 and 4, it is in the non-operative state. For this reason, the horizontally-polarized-wave signal HP is decreased by HEMT elements 3 and 4, and only few signals get across to a latter circuit. Although the relative-level difference of the vertically-polarized-wave signal and horizontally-polarized-wave signal which are outputted from an output terminal 11 is called an isolation property or cross polarization signature, the degree of separation of both the polarization signal will be so high that this difference is large, and it will be desirable.
[0026] Next, if supply voltage is set to 17.0V, a comparator circuit 15 will judge beyond as a reference value, will switch a switching circuit 14, and will supply bias voltage to HEMT elements 3 and 4. Thereby, a converter circuit serves as the horizontally-polarized-wave signal receive mode, after low noise amplification is carried out by HEMT elements 3 and 4, and a horizontally-polarized-wave signal is supplied to a band-pass filter 7 and changed into an intermediate frequency signal (950 MHz - 2050MHz) with the HEMT mixer 8, is amplified by suitable level by the intermediate frequency amplifying circuit 10, and is outputted from an output terminal 11.
[0027] Drawing 2 is the graph which compared the relative output level of the vertically-polarized-wave signal VP at the time of vertically-polarized-wave signal reception, and the horizontally-polarized-wave signal HP. This graph shows the output frequency (0.2 GHz/div) to the vertical axis on the horizontal axis of input frequency (0.2 GHz/div) and a top at the horizontal axis of a relative output level (10

dB/div) and the bottom, respectively. the 1.1GHz wide band over of [this circuit has obtained 31dB as the minimum value of isolation so that clearly from this graph, and] 10.7GHz - 11.8GHz in input frequency -- it turns out that it has high degree of separation [0028] Drawing 3 is the graph which compared the relative output level of the horizontally-polarized-wave signal HP at the time of horizontally-polarized-wave signal reception, and the vertically-polarized-wave signal VP. The output frequency (0.2 GHz/div) is shown in the vertical axis on the horizontal axis of input frequency (0.2 GHz/div) and a top like [this graph] drawing 2 at the horizontal axis of a relative output level (10 dB/div) and the bottom, respectively. the wide band over whose input frequency 31dB has been obtained as the minimum value of isolation also in this case, and is 10.7GHz - 11.8GHz -- it has high degree of separation

[0029] Drawing 4 is the graph which shows comprehensive gain and a noise figure property, the comprehensive gain PG (2 dB/div) is shown in the vertical axis of a noise figure NF (0.1 dB/div) and the right, and input frequency (0.1 GHz/div) is shown in the horizontal axis at the left vertical axis, respectively. A solid line expresses the time of reception of the vertically-polarized-wave signal VP among drawing, and the dashed line expresses the time of reception of the horizontally-polarized-wave signal HP. It turns out in the time of reception of a vertically-polarized-wave signal, and reception of a horizontally-polarized-wave signal that the difference of the frequency characteristic of the comprehensive gain PG is a **1-**2dB small margin so that clearly from this graph.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing one example of the converter circuit by this invention.

[Drawing 2] It is the graph which compared the relative output level of the vertically-polarized-wave signal and horizontally-polarized-wave signal at the time of vertically-polarized-wave signal reception.

[Drawing 3] It is the graph which compared the relative output level of the horizontally-polarized-wave signal and vertically-polarized-wave signal at the time of horizontally-polarized-wave signal reception.

[Drawing 4] It is the graph which shows the comprehensive gain and the noise figure property at the time of vertically-polarized-wave signal reception and horizontally-polarized-wave signal reception.

[Drawing 5] It is the block diagram showing the 1st example of the conventional converter circuit.

[Drawing 6] It is the block diagram showing the 2nd example of the conventional converter circuit.

[Drawing 7] It is the block diagram showing the 3rd example of the conventional converter circuit.

[Drawing 8] It is the block diagram showing the 4th example of the conventional converter circuit.

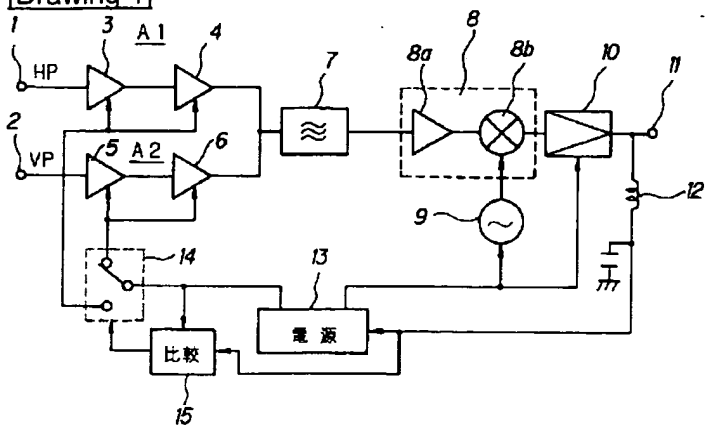
[Description of Notations]

1 Two Input terminal
3, 4, 5, 6 HEMT element
7 Band-pass Filter
8 HEMT Mixer
8a HEMT element
8b Mixer
9 Local Oscillation Circuit
10 Intermediate Frequency Amplifying Circuit
11 Output Terminal
12 Choke Circuit
13 Power Circuit
14 Switching Circuit
15 Comparator Circuit
A1 1st low noise amplifying circuit (LNA)
A2 2nd low noise amplifying circuit (LNA)

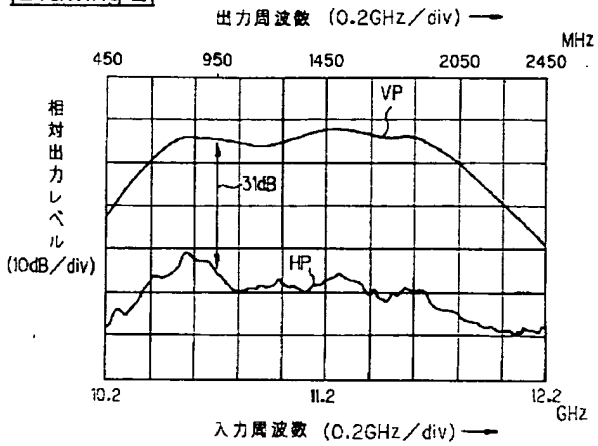
[Translation done.]

DRAWINGS

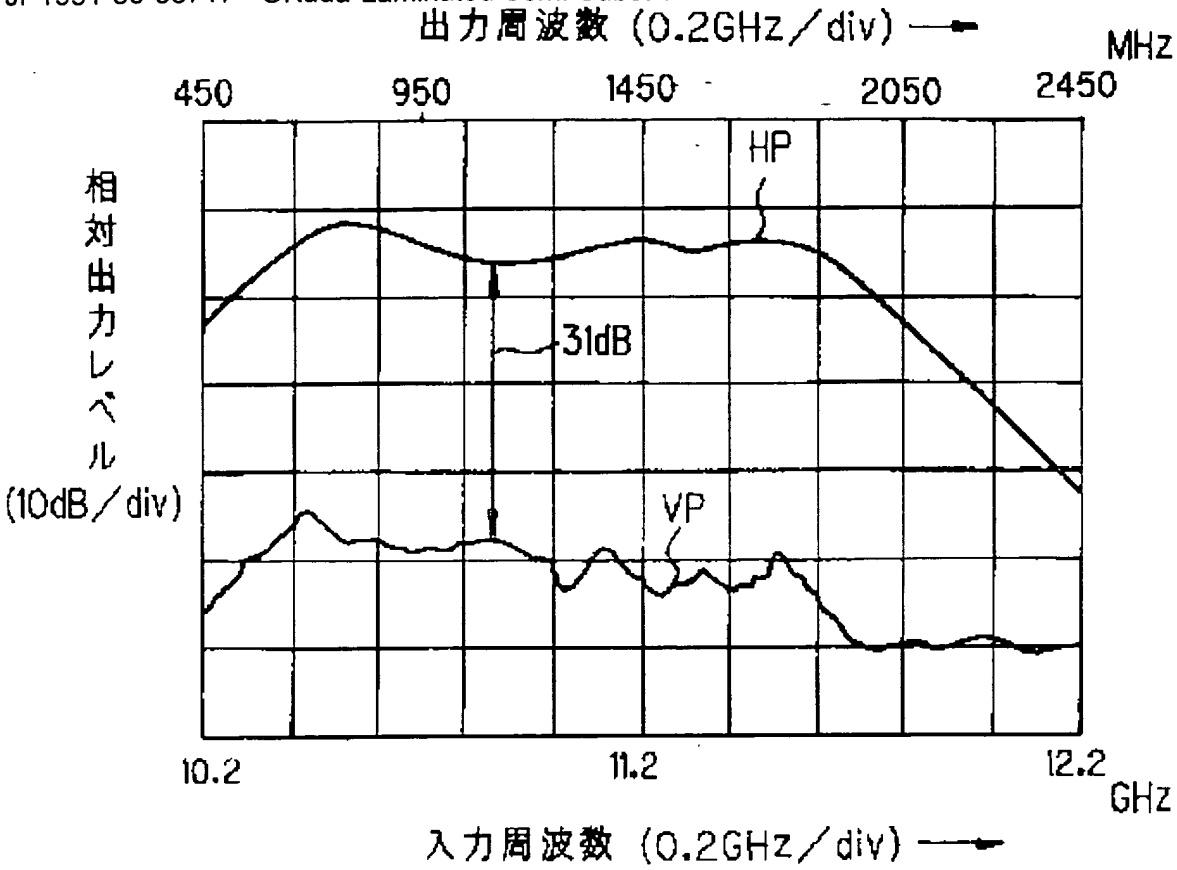
[Drawing 1]



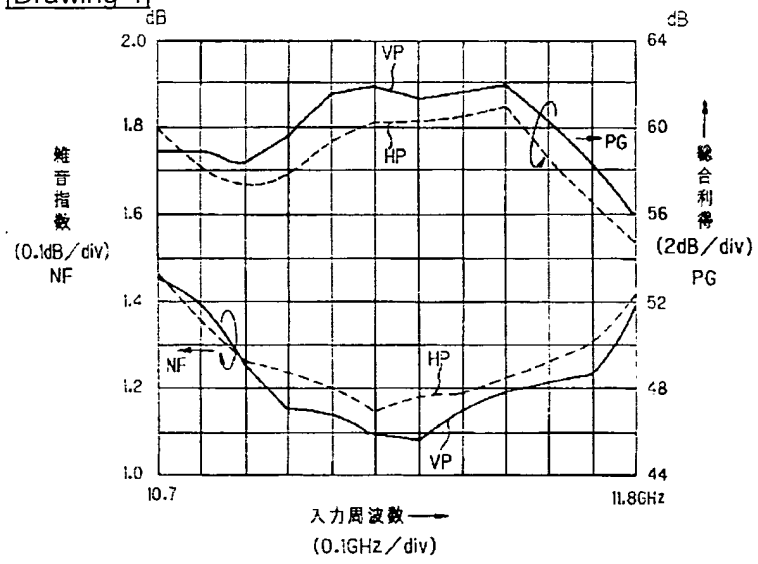
[Drawing 2]



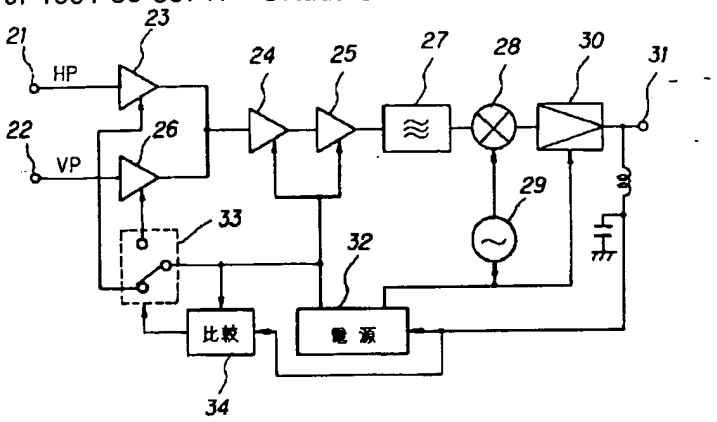
[Drawing 3]



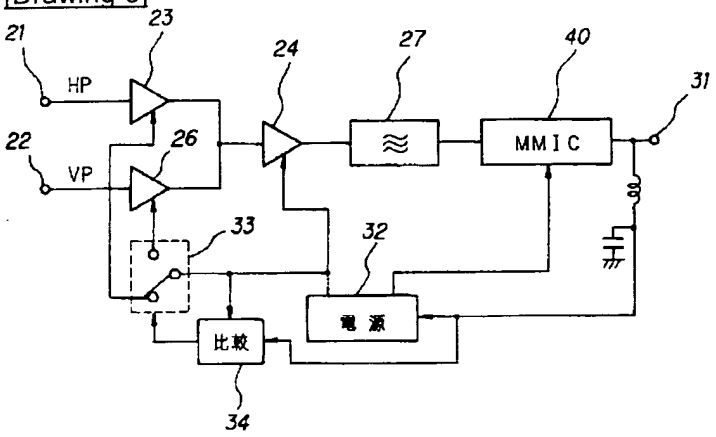
[Drawing 4]



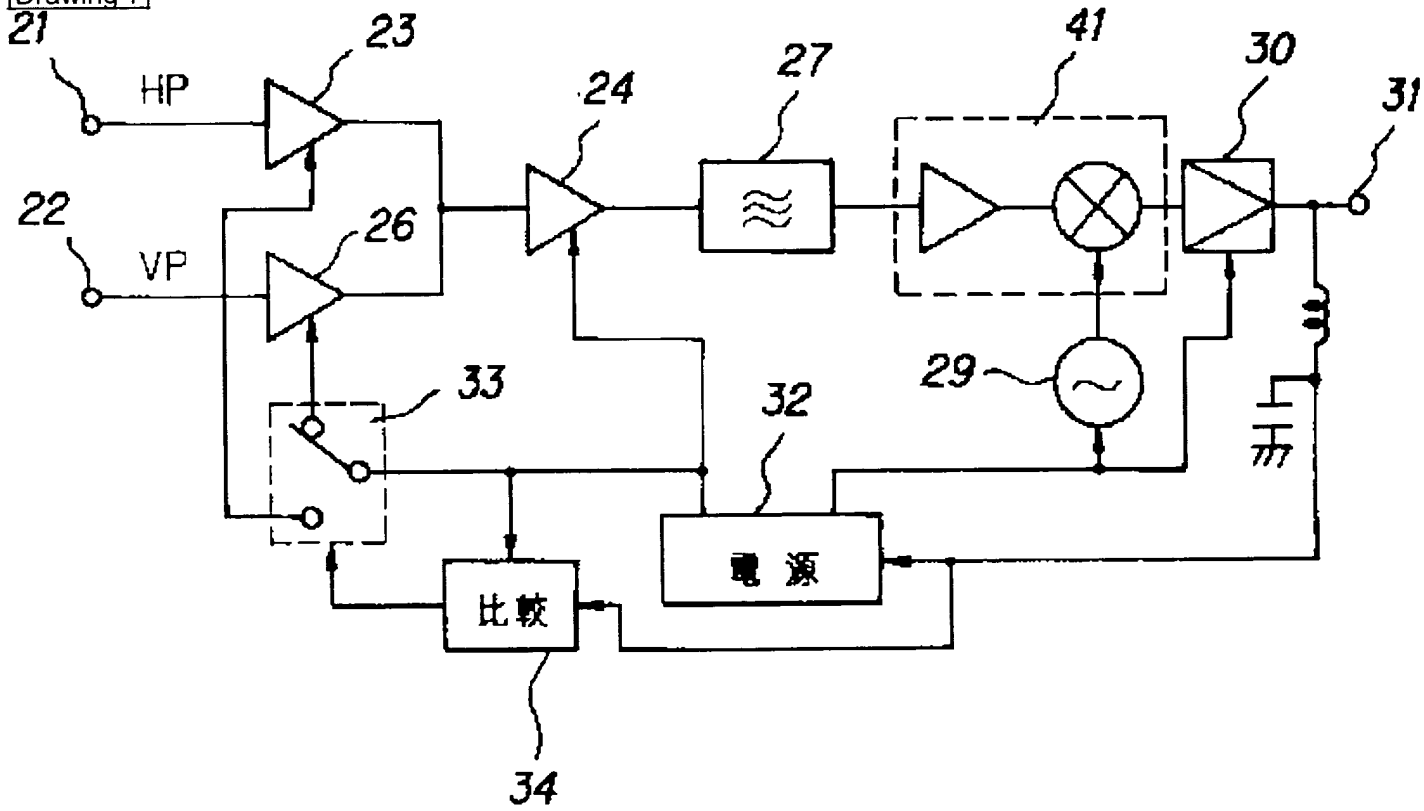
[Drawing 5]



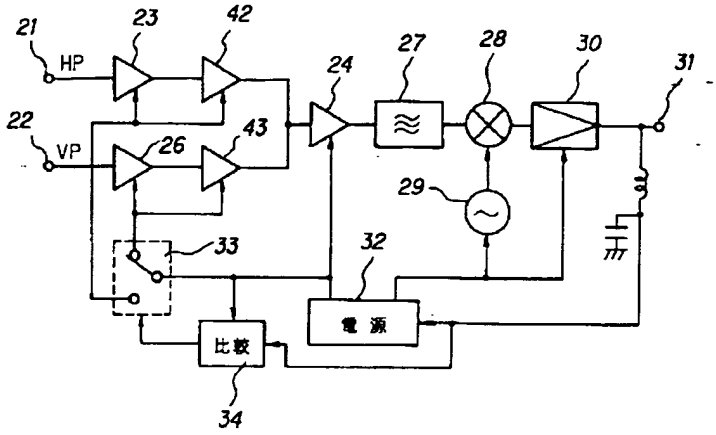
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]